Upgrades to the M-PERC and PERC Models to Improve Short Term Tropical Cyclone Intensity Forecasts

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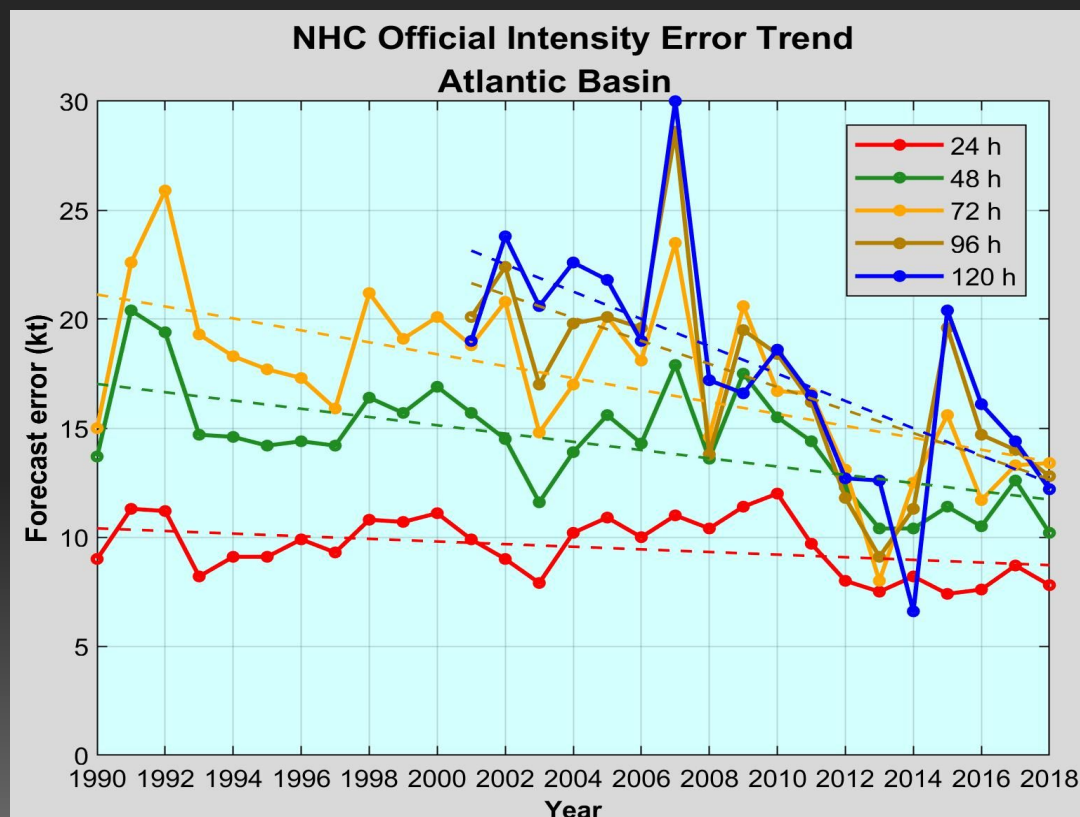**JHT Update: March 10, 2022**

ERC Onset Guidance: M-PERC

Goal – Make incremental improvements to short range forecasts by giving forecasters a tool that objectively identifies Eyewall Replacement Cycle (ERC) onset.

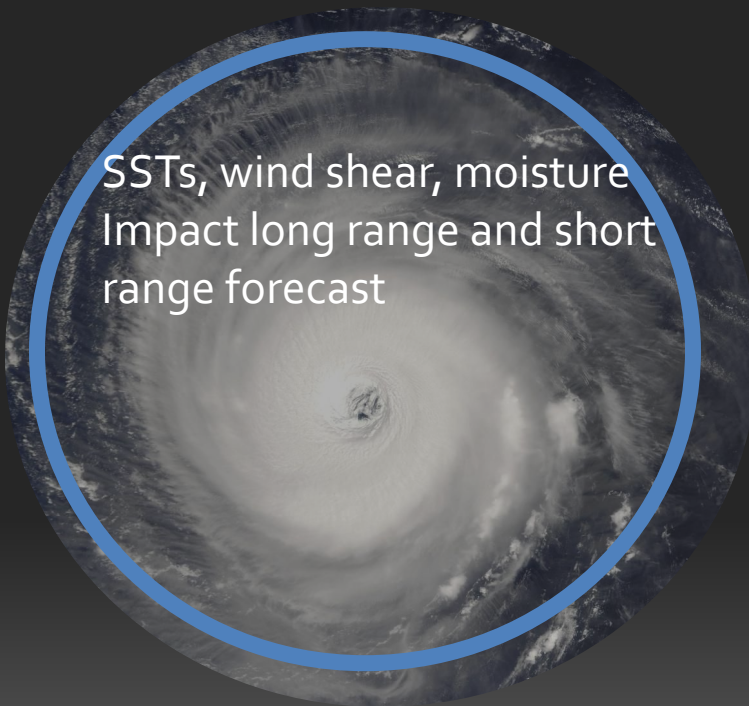**Microwave Probability of Eyewall Replacement (M-PERC) model**

M-PERC was developed using Atlantic data but runs in all basins
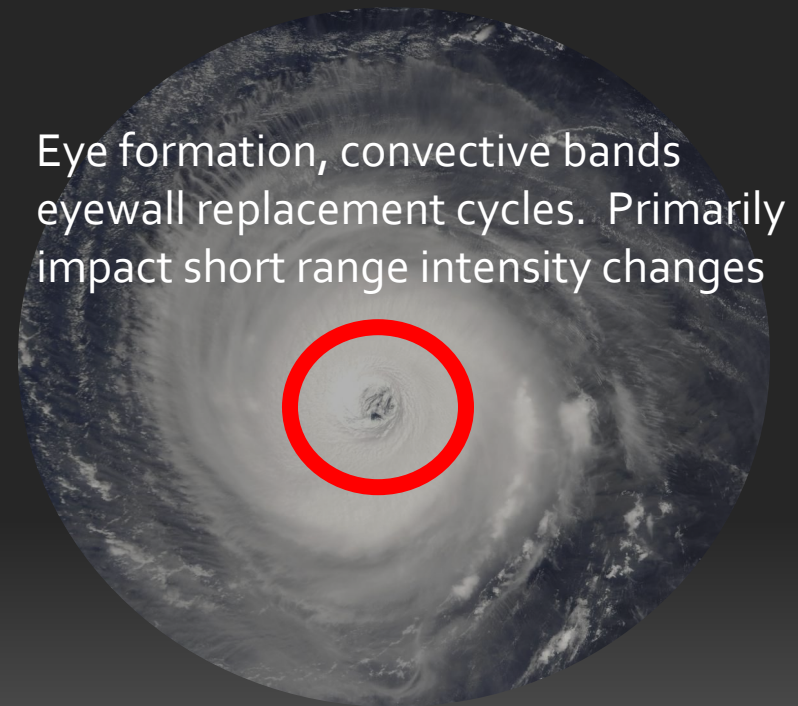
Develop M-PERC version for Epac/Cpac

NHC Official Intensity Error Trend Atlantic Basin

Legend:
- 24 h
- 48 h
- 72 h
- 96 h
- 120 h

Y-axis: Forecast error (kt)
X-axis: Year

TC Intensification

Environmental Controls

Internal Controls

SSTs, wind shear, moisture
Impact long range and short
range forecast

Eye formation, convective bands
eyewall replacement cycles. Primarily
impact short range intensity changes

"The disparity between SHIPS forecasts and the observed intensity changes during ERCs is strongly suggestive that the typical environmental controls of intensity change, on which SHIPS is largely based, are temporarily **countermanded** while dynamic processes internal to the storm dominate the intensity evolution."- Kossin
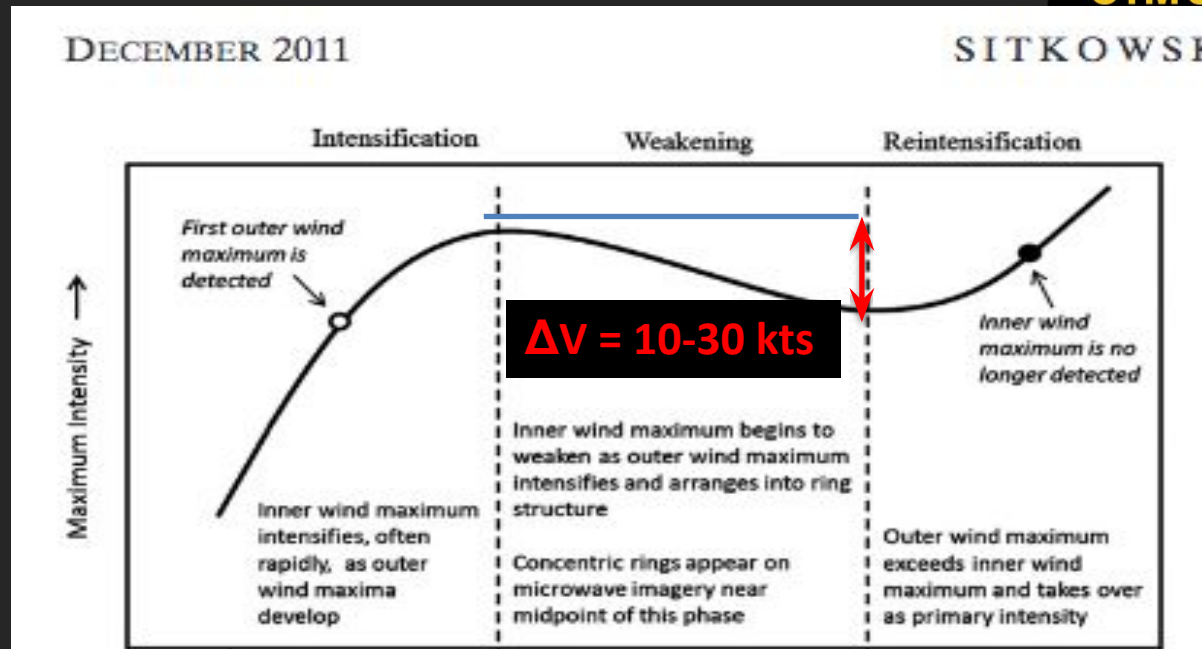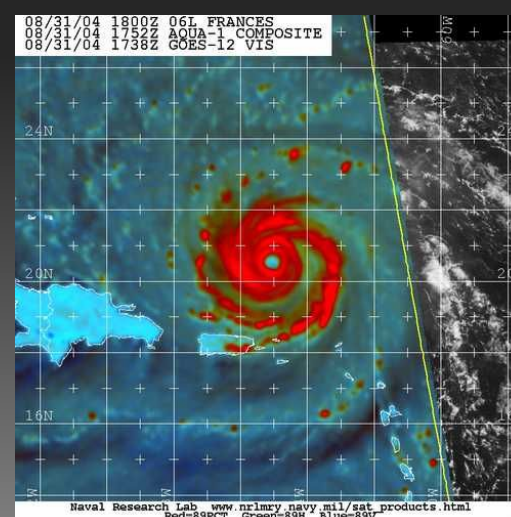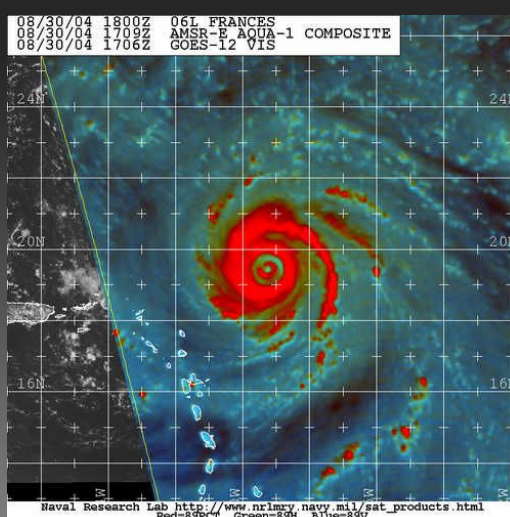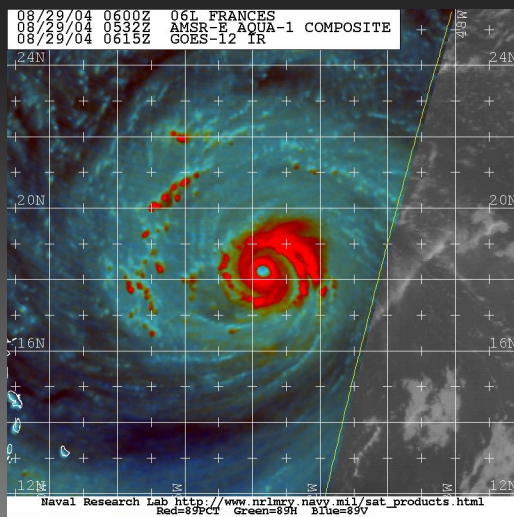
TC intensity change paradigm from Sitkowski et al 2011

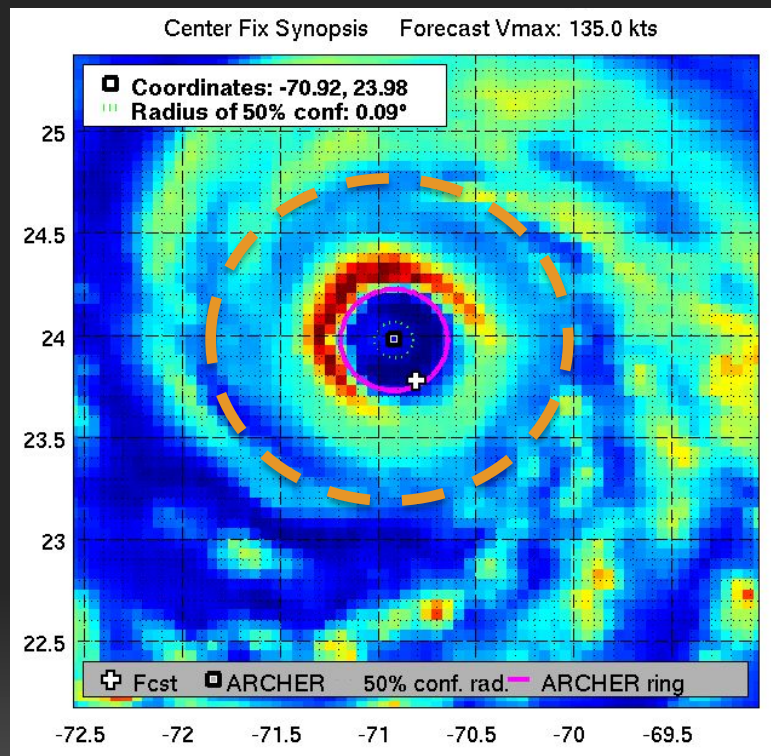This however is not true for all storms as we will see

Sitkowski, M., J. P. Kossin, and C. M. Rozoff, 2011: Intensity and structure changes during hurricane eyewall replacement cycles. *Mon. Wea. Rev.*, **139**, 3829-3847.

ARCHER ring score

Best Track Intensity

Model Probabilities

Ring scores can be displayed in hovemöller form to show time and space evolution of the features.

Center Fix Synopsis   Forecast Vmax: 135.0 kts

Coordinates: -70.92, 23.98
Radius of 50% conf: 0.09°

Fcst   ARCHER   50% conf. rad.   ARCHER ring

9/12

9/13

9/14

9/15

9/16

*ARCHER ring score plotted versus time shows a branching/merging pattern during ERCs

0   50   100   150   200

Radius, km

Vmax, knots

Some support for basin dependence and maybe also data period/training for use in real-time model output

http://tropic.ssec.wisc.edu/real-time/archerOnline/web/index_erc.shtml

TC intensity change paradigm
from Sitkowski et al 2011

Recent work indicates that the subsequent intensity pathway is often
dependent on storm intensity. This has implications for the application of
M-PERC (and PERC as well) for the intensity forecast process that uses
knowledge of imminent ERC onset.

- Lower probability M-PERC events (peaks of 25% -60%) during
  intensification may verify as fast resolving ERCs with
  less impact on intensity (slower intensification for ~12 hours or a pause).
- Higher probability events > 60% are more likely to result in weakening

TC intensity change/ERC length for ERC events binned by intensity category

How can forecasters adjust intensity forecasts based on M-PERC?

Cat 1-2 ERCs are faster and result in less weakening or none at all (a pause in RI)

Cat 4-5 ERCs take longer and result in more weakening. TCs may not return to previous intensity (LMI occurs prior to ERC)

Results will guide future M-PERC, E-SHIPS, PERC work

Plots created in collaboration with Xi Guo
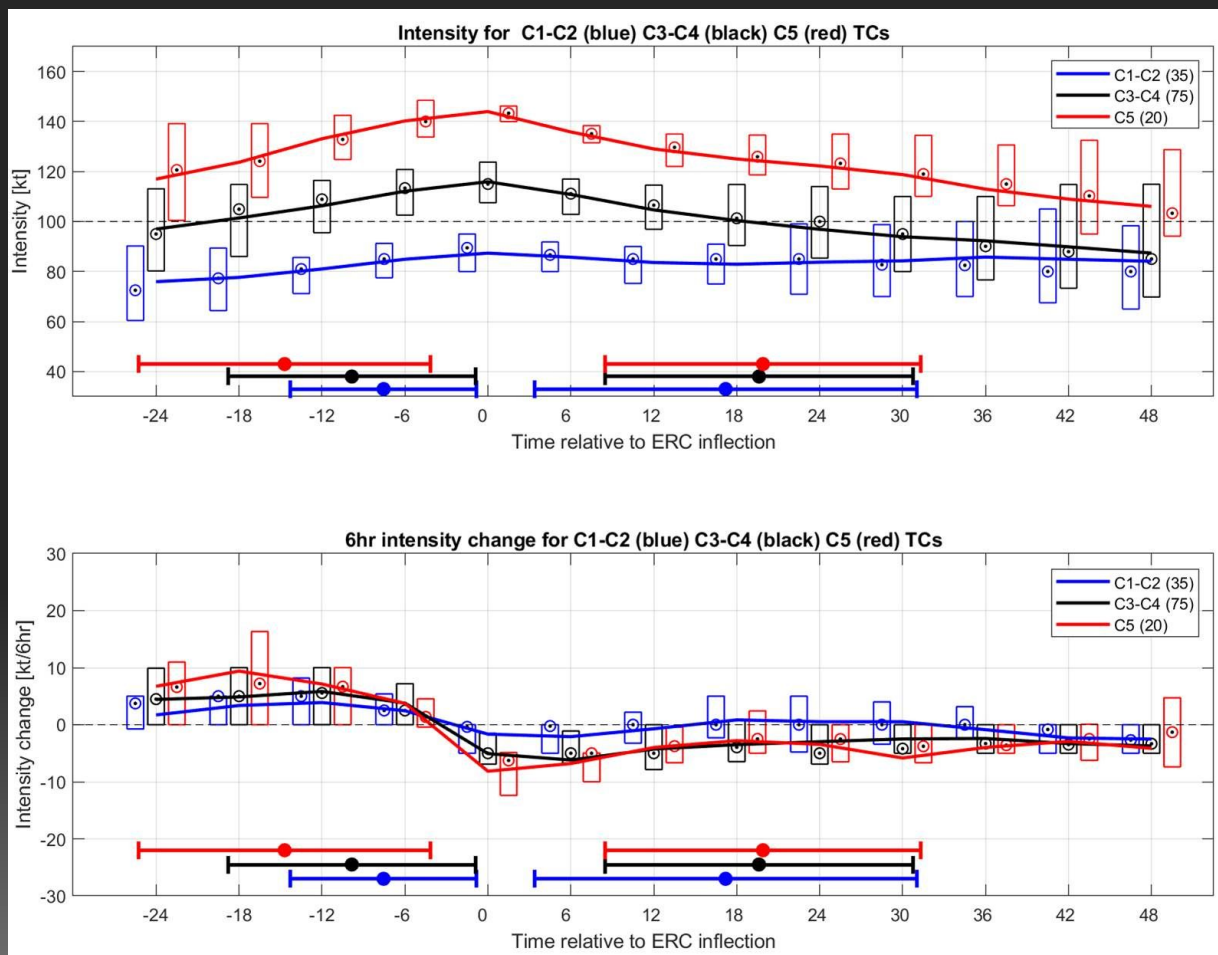
RI events following an ERC
21 % of ERC events have a
period of RI following the
event

ERC moves Vmax away from
MPI providing "space" for
re-intensification.

AL112015

Hurricane Joaquin

ERC Events

25 knots
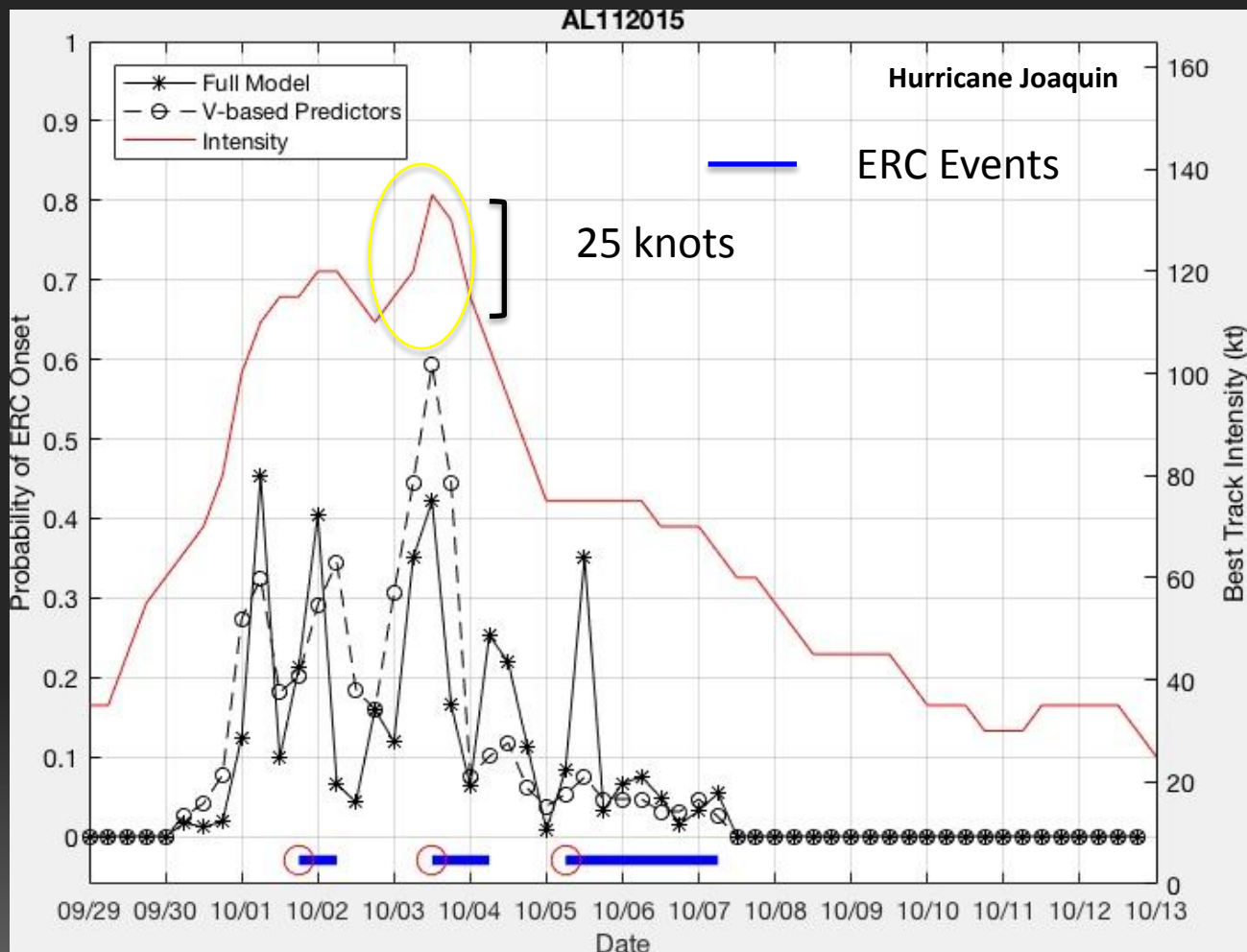
ERC Onset Guidance: M-PERC

Hurricane Felicia 2021

89 GHz

17/18Z

18/00Z

18/06Z
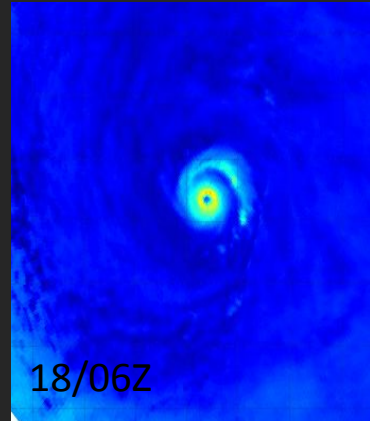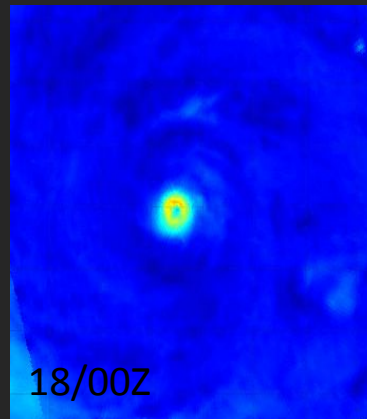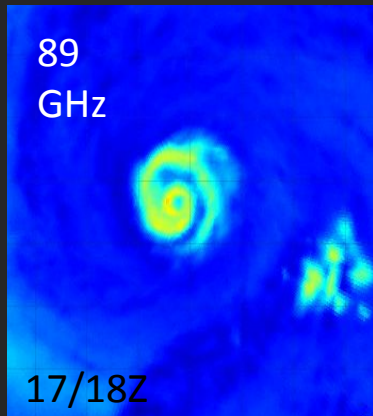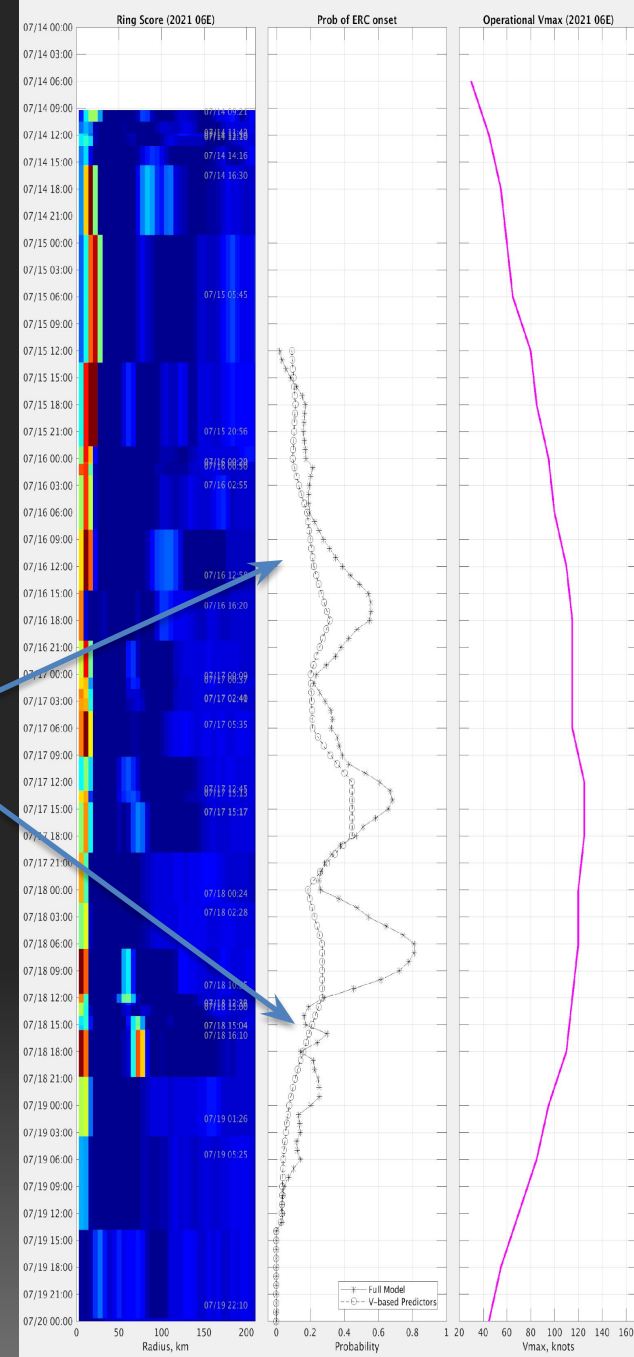
Fluctuation between banding and annular.

M-PERC values may oscillate for some storms. Especially in Eastern Pacific as storms mover close to marginal environment.
- Entrainment of more stable air
- Diurnal fluctuations

Project status as of March 10, 2022

Tasks	Status	Completion
Identify East/Central Pacific ERC events in data period	100%	June 2020
Baseline extisting M-PERC in Eastern Pacific	100%	June 2020
Develop East/Central Pacific microwave training data	100%	June 2020
Develop M-PERC model for East/Central Pacific data	75%	March 2022
Port MATLAB M-PERC code to Python	75%	May 2022
Add SHIPS parameters such as shear/sst to M-PERC display	100%	Testing 2022
Investigate M-PERC probability inputs to PERC model	0%	June 2022
Develop logistic regression version of PERC model	20%	June 2022
Transition PERC model to East/Central Pacific	0%	June 2022
Publish results for M-PERC model	99%	March 2022
Add PERC output to graphics display	10%	June 2022

Code transition plan:
- Full M-PERC python package will be placed on GitHub
- M-PERC integration into GeoIPS
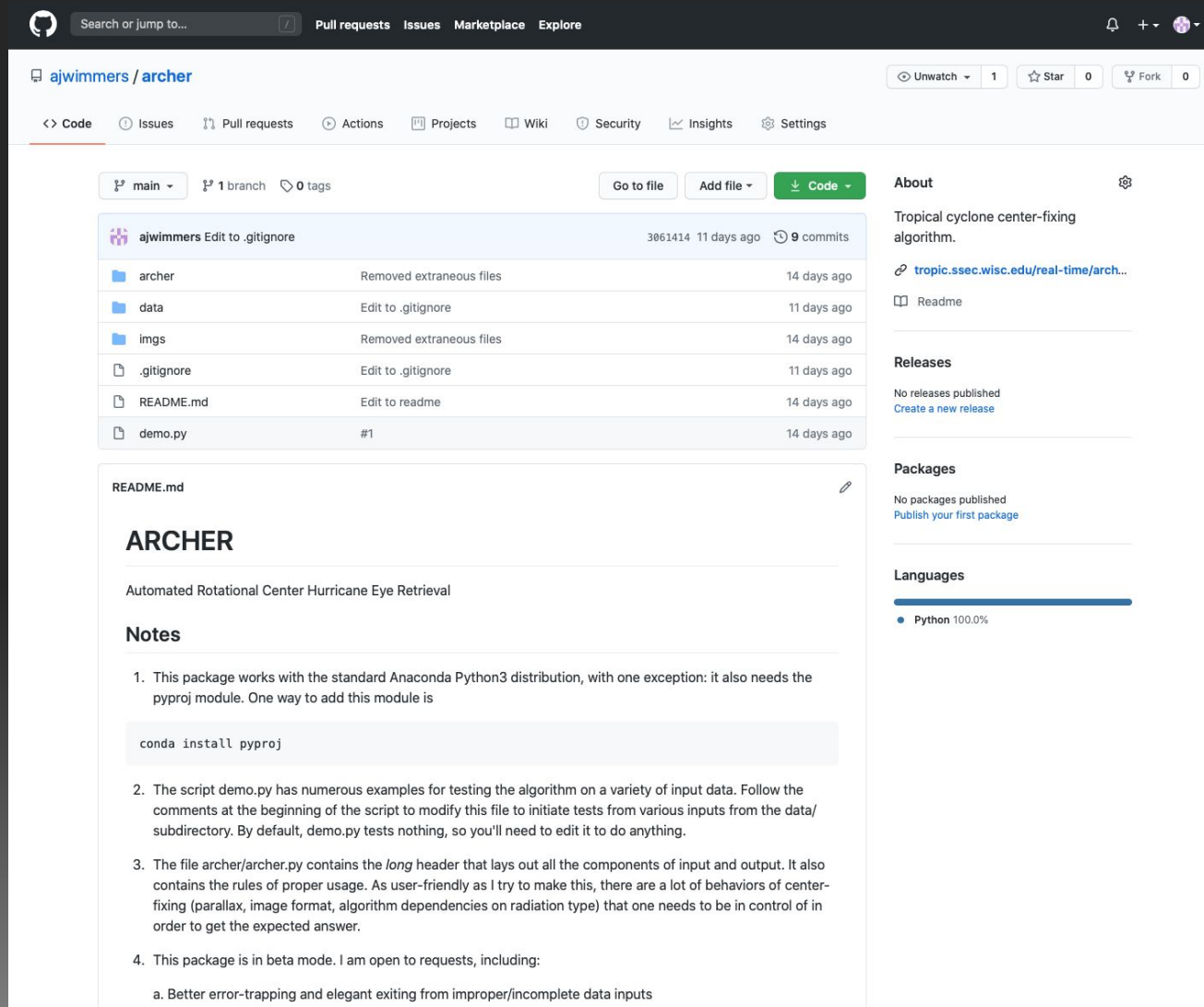- Install on WCOSS2 in 2023 (code installs frozen for 2022)

Port code from Matlab to Python and add additional diagnostic information

ARCHER (front end to M-PERC) has been ported to python and tested.

- processes the mw imagery and produces the ring scores fed to M-PERC

Available via GitHub

Integrating currently into GeoIPS

Port code from Matlab to Python and add additional diagnostic information

Back end of M-PERC graphics production to create ring score hovmöllers and M-PERC model plots completed.

Testing real-time python code and SHIPS sst/shear plots is underway for latest version of M-PERC
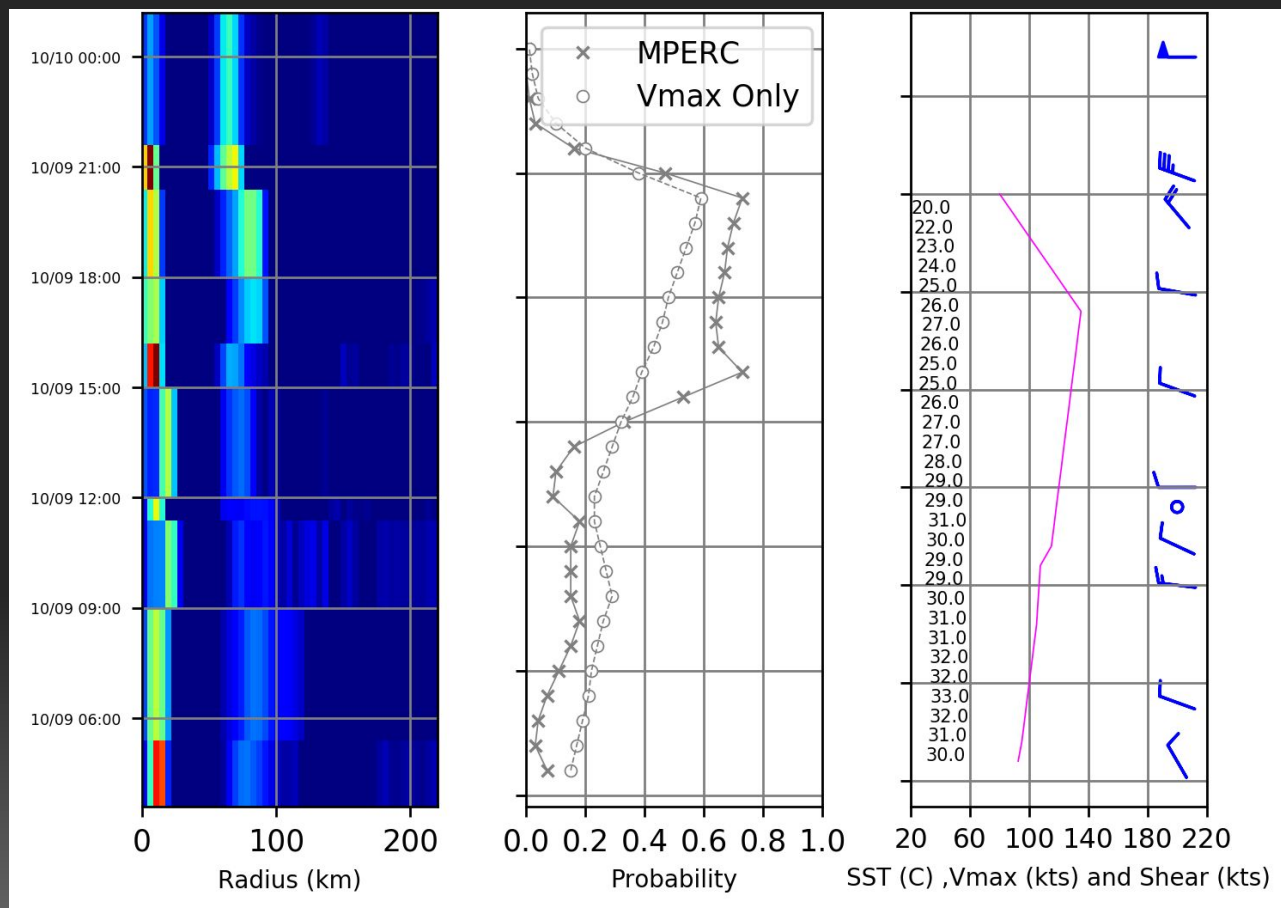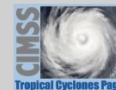
Questions ?

M-PERC (Microwave-based Probability of Eyewall Replacement Cycle)

ARCHER Page | Product Description | Archive Directory

Current time: Thu, 09 Sep 2021 03:24:45 GMT

Active Tropical Cyclones

Atlantic
Hurricane Larry
Tropical Storm Mindy

East Pacific
Tropical Storm Olaf

West Pacific
Tropical Storm Conson
Super Typhoon Chanthu

Australia/Fiji Region

Indian Ocean

M-PERC Announcements and Updates

2016 Jul 15: ARCHER-ERC is now online! We welcome any feedback as you look over the product and find any possibilities for improvement.

Links and Affiliations:

http://tropic.ssec.wisc.edu/real-time/archerOnline/web/index_erc.shtml